COORDINATES OF FOOD WASTE

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Abstract
Studying food waste is crucial to achieving sustainability goals and ensuring global food security. A thorough understanding of food waste issues and the development of effective solutions requires detailed research and analysis. Through food wastage studies, effective strategies and policies can be developed to help reduce this major problem and support a more equitable and sustainable food system. Studying the factors causing food waste and itssocial, economic, environmental and nutritional implications helps stakeholders to better understanding this global issue and to identify solutions for its reduction.

Keywords: *Food losses, Food security, global issue, bibliometric analysis, Global Food Loss Problem.*
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Introduction

Food waste is a global problem recognised by the international community, with FAO estimates (FAO, 2011) indicating that a large proportion of the food produced globally for human consumption does not reach its intended use.

Food waste is a complex phenomenon that is difficult to fit into a single domain, as it has diverse implications: economic, environmental, social, political and nutritional. The economic effects refer to the fact that food waste is in fact a waste of material, energy and human resources, which is opposite to the very definition of economics - the efficient use of resources. The environmental approach relates to the storage of wasted food and thus increased water, soil and air pollution. Moreover, the new paradigm of sustainable development, with the environment as one of its pillars, envisages the use of global resources with intergenerational solidarity, and food waste runs counter to this approach by its excessive and indiscriminate use of resources. The social effect relates both to the redistribution of food that is about to expire to the disadvantaged people and to the social stability of a state where, if food security is ensured, including by reducing food waste, then social security is also guaranteed. In the political sense, food wastage is regulated by laws, implementing rules, regulations etc. Last but not least, the nutritional implications are that wastage is seen as a missed opportunity in a world where more than 800 million people suffer from hunger, a form of malnutrition. Thus, the complexity of the approaches and implications of food waste makes it an important component of sustainable development and an economic, environmental, social, political and nutritional priority.

Waste is defined in Law 217/2016 on the reduction of food waste as the situation where food goes out of human consumption due to spoilage and is destroyed, according to the legislation in force (Art. 1(2)). The law specifies that the reduction of food waste is an objective pursued by all economic operators in the food sector and provides for measures that they can take in this direction, as well as the tax facilities available to operators in case of food donation. Through this fiscal leverage, economic operators are encouraged to reduce food losses for which they are responsible at the stage of the food chain at which they operate. Thus, at the level of the agri-food chain, producers, processors and distributors have specific economic tools to reduce losses, less so consumers. Consumers' only motivation to reduce waste is financial loss, understanding that with discarded products, they lose the money paid to buy them.

Waste is defined in FAO documents and is differentiated from the concept of loss. In the FAO (2019) report on the state of agriculture, including food wastage, the terms are defined as follows: food loss means a reduction in the quantity or quality of food as a result of the decisions and actions of operators in the supply chain, excluding retailers, food service providers and consumers. Food waste means a decrease in the quantity or quality of food as a result of the actions of retailers, food service providers and consumers. This distinction is not made in the literature, so in this study the term waste will be used both for losses that occur up to food retailing and for wastage that occurs from food stores through restaurants to final consumers.

1. Literarure review

The study of food waste is central to scientific concerns and is addressed in many research areas. A search of the WoS database on food waste has reported 45,656 publications since 1975. Figure 1 shows the dynamics of these, starting in 2000, when an average of 200 papers were published per year, rising 20 years later to over 5,000 papers and now 6,500 publications per year. The scientific community's interest in studying this topic has gradually and naturally increased with the transition from the Millennium Development Goals to the 2030 Agenda, including Goal 2 (SDG2), Eradicate hunger, ensure food security, improve nutrition and promote sustainable agriculture. In this context, where the aim is sustainable agricultural development and food waste must be reduced, the academic world is trying to find solutions to achieve this goal, with the number of scientific publications increasing in recent years.

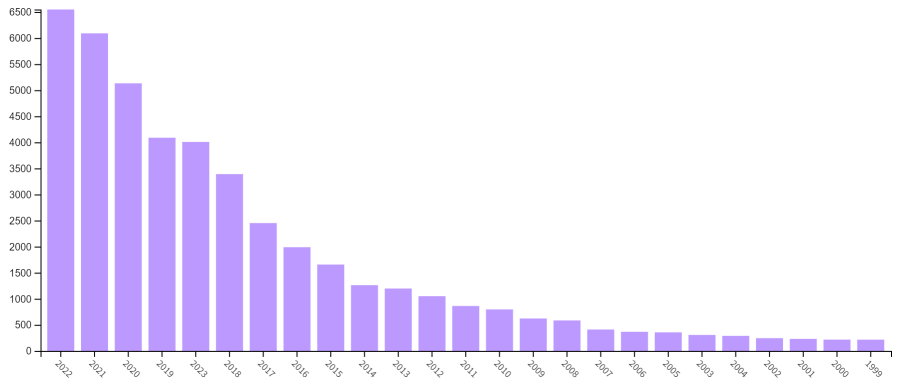

Figure 1. Dynamics of the number of publications on food waste, 2000-2022

Source: processing the results provided by WoS on the food waste survey

In terms of areas of publication of papers on food waste, the main area of publication is environmental sciences (27% of articles), followed by food science technology (15%) and environmental engineering (12%). Other areas in which papers on food waste have been published are energy fuels, applied biotechnological microbiology, sustainable green science technology, chemical engineering, agricultural engineering, multidisciplinary chemistry, nutrition, environmental studies, etc.

Analysing the first 1,000 articles sorted by relevance, 10 papers contain the word Romania in the abstract. Oroian (et al., 2021) studied the behaviour of the Romanian consumer in relation to food waste, using a survey research method, conducted on a sample of 114 respondents. The results show that the main category of wasted food is represented by cooked food, due to the fact that people cook more than they need. Chereji (et al., 2023) examines the same theme using the survey and finds that young people throw away more food than older consumers, and awareness of food waste is more evident in young adults, with no significant correlation regarding urban or rural settings. Iorga (et al., 2017) identifies the profile of the Romanian consumer prone to food waste, characterizing them as young, under 35 years old, living in large cities, with university education and medium to high income, with the preferred place of purchase being food retail. Dumitru (et al., 2021) identified, with the help of the survey, a trend of waste reduction among Romanian consumers in 2020 compared to 2016, a trend that could be explained by the increase in consumer responsibility towards sustainable behaviour.

In Figure 2 the data resulting from querying the Web of Science database using the keyword food waste is processed using the VOSviewer program. Four main clusters resulted according to link intensity and theme.

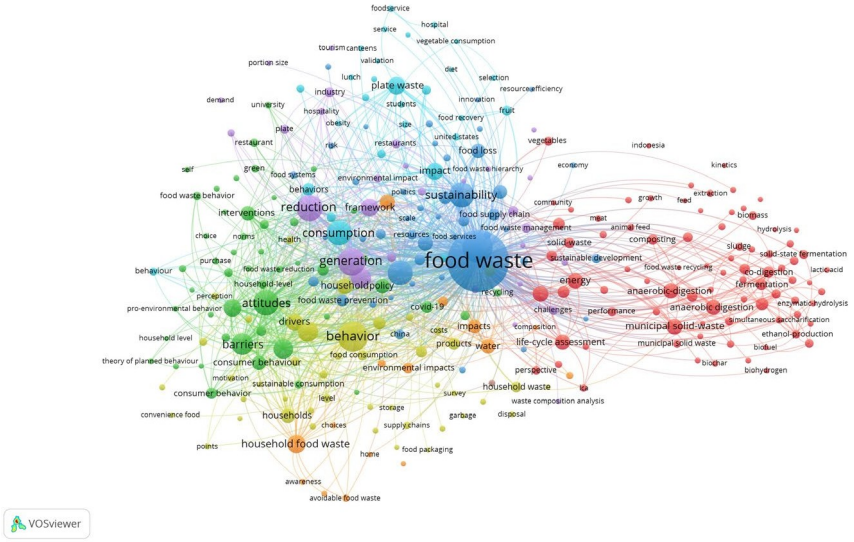

Figure 2. Thematic links of food waste
Source: data processing using VOSviewer

1.1 The environmental effects of food waste

The first group, illustrated in red, includes keywords related to the environmental aspect of food waste, with links to product life cycle, waste management, municipal waste,

composting, biomass, environment, etc. Schott and Andersson (2015) investigated the environmental impact of reducing household food waste, showing that although modern alternatives for treating food waste can lead to avoiding increased global warming effects through nutrient and energy recovery, preventing food waste has much greater benefits compared to both incineration and anaerobic digestion. Other studies (Matsuda et al., 2012) show that preventing food waste leads to a significant reduction in greenhouse gas emissions.

1.2 Factors influencing food waste

The second group, illustrated in green, is related to factors influencing food waste from a consumer behaviour perspective and is related to words such as attitudes, beliefs, behaviour, behaviour change, choices, design, determinants, etc. Some research (Nunkoo et al., 2021) is directed towards understanding households' attitudes towards food waste and their motivations and barriers to food waste recycling. The views expressed by participants in this study regarding food waste relate to guilt towards food waste, lack of awareness of environmental effects, financial considerations, etc.

Some studies in this category show the causes of food waste. Schanes (et al., 2018) classifies the reasons for food waste into two main categories. The first category refers to the understanding related to waste and consumers' perceptions of food waste. The second category refers to household practices and routines related to food - planning, shopping, storing, cooking, managing leftovers, assessing edibility and discarding food waste. Similar results are demonstrated by other studies (Leverenz et al., 2019), which show that the main drivers of food waste in households are preparing too much food for current consumption, food spoilage during storage, not using what could be saved in time, expiry of shelf life, making handling mistakes, etc. Variables that cause households to waste food include household size, household type and budget allocated to food purchases, with families with children and large food budgets increasing the incidence of food waste (Parizeau, 2015). An inverse relationship has been found between shopping frequency and waste (Williams et al., 2012).

1.3 Consumer behaviour sensitive towards food waste

The marketing research group on food waste, illustrated in yellow, includes keywords such as behaviour, perceptions, motivations, segmentation, factors, surveys, households, etc. and is related to the previous group, which includes factors influencing food waste, including wasteful consumer behaviour. Janssens (et al, 2019) shows that the main driver of food wastage is in-store purchasing behaviour, specifically, study participants claimed that buying more food than needed often led to food waste. Other studies on consumer behavior and perceptions of food waste (Misiak et al., 2020) show that there are two categories of reasons for moral disapproval of food waste, one outwardly oriented, characterized by concern for the environment, social problems and future generations, and one inwardly oriented, characterized by concern for financial situation, social approval, being guided by traditional rules. It was observed that only people motivated by outward-oriented factors wasted food less often. In addition, consumers' attitude towards food waste, display of controlled behavior and awareness of product prices are behavioral factors that reduce food waste (Coşkun and Özbük, 2020).

1.4 Food waste as a global issue

Another group, illustrated in blue, includes keywords such as sustainable, food security, food chain, food policy, agriculture, food systems, retail, and is about the policy-regulated aspect of food waste and its implications for ensuring food security. Food wastage is seen as a barrier to ensuring food and nutrition security for millions of undernourished people around the world (Bagherzadeh et al., 2014). Research clearly shows the link between waste and household food security, demonstrating that moderately food insecure households were

associated with an increased likelihood of wasting uncooked food, mildly and moderately food insecure households were associated with an increased likelihood of wasting cooked food. In contrast, households in which food security is assured were associated with a decreased likelihood of wasting cooked food (Althumiri et al., 2021). The problem of food wastage could be addressed through a logistical approach to collecting surplus food and distributing it to those in need, with the broader aim of achieving sustainable food security (Wu and Lin, 2023). Such initiatives are found in many agrifood systems, including Romania. This bibliometric analysis shows the multidisciplinary nature of food waste, which, as demonstrated, is difficult to fit into a single field of study. The diversity of disciplinary approaches and the complexity of its impact in many directions gives food waste a special place both in scientific concerns and in the practical approach to reducing it.

2. Benchmarks on the extent of food waste in the world

As specified, food losses and waste result along the entire food chain, from cultivation, agricultural production, harvesting, processing of agricultural products, their storage and distribution, to final consumption in households or restaurants, with different causes, as scientific research shows (Cicatiello et al., 2017). Globally, FAO (2019) estimates that 1.3 billion tonnes of food (or about one third of food production for human consumption) are lost or wasted, on average, per year.

The food wastage index, calculated as the ratio of food wastage in 2021 to food wastage in 2015, is presented in Figure 3, showing that, over this period, waste has increased in some regions of the world (North America, Latin America, Europe) and decreased in others (Sub-Saharan Africa, Central and East Asia).

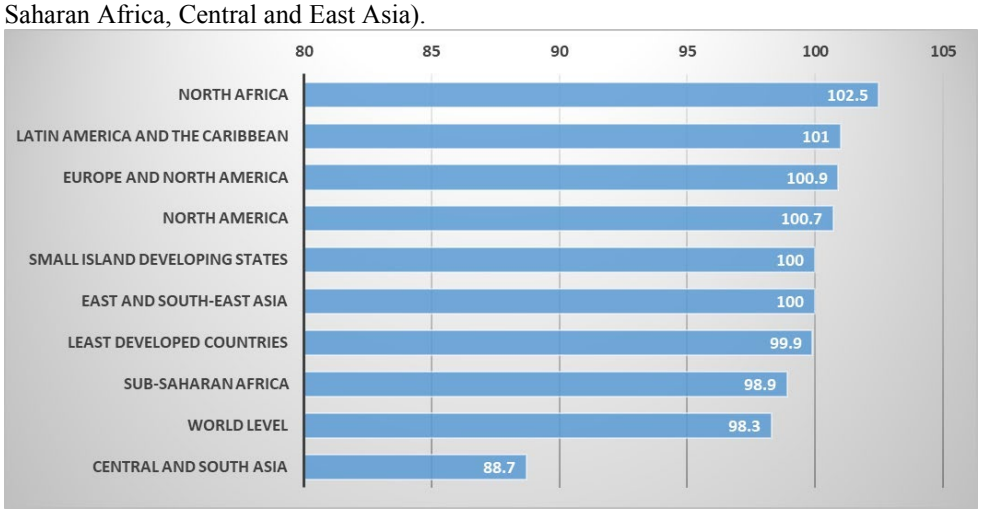

Figure 3. Food wastage index, 2021 (2015=100), in world regions (%)

Source: FAO

Figure 4 shows food waste per capita, expressed in kilograms per person and broken down by source (food retail, consumption outside the household and consumption in the household). Globally, an average of 120 kilograms of food is wasted per person, with the largest share at household level, 74 kg/person (61%). High levels of wastage are observed in Africa, the region most affected by hunger, with an average of 153 kg/person, including sub-Saharan Africa, where wastage is 157 kg/person. More than 100 kg of food is thrown away on average per year in African households. In other regions of the world, wastage is 134 kg/person in North America, 127 kg/person in Oceania, 116 kg/person in Latin America, 114

kg/person in Asia, 103 kg/person in Europe, with most of it at household level. In Romania, waste is 108 kg/person, slightly higher than the average in Europe, with 64% at household level.

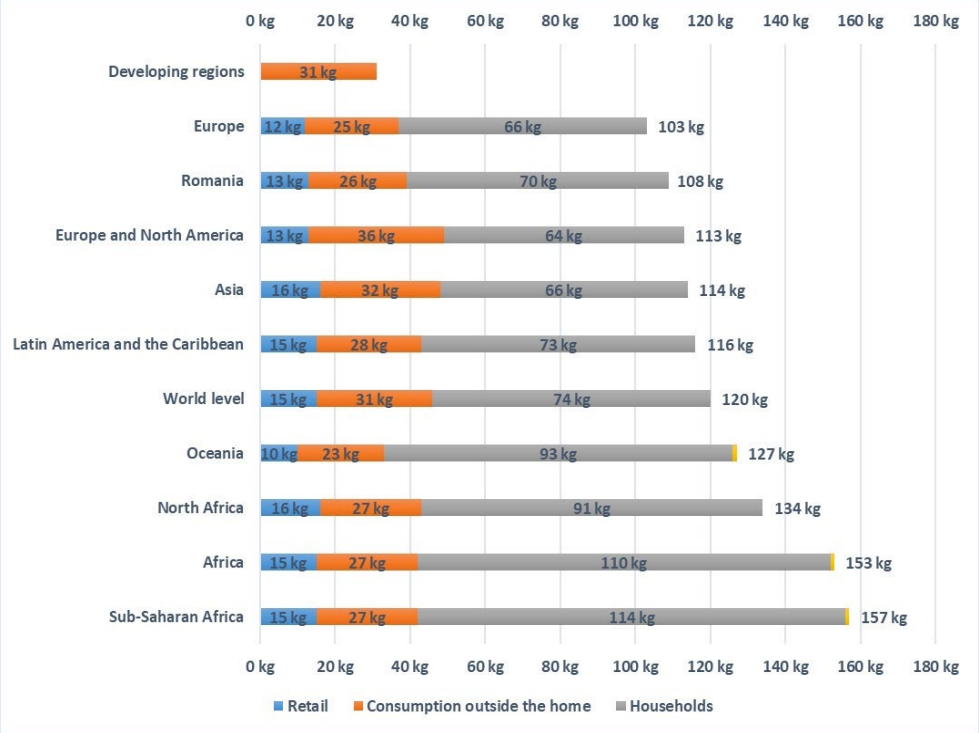

Figure 4. Food waste per capita in world regions and Romania, 2019 (kg/person)
Source: FAO

3. Measures to reduce food waste

There are many concerns to reduce food waste, globally, regionally and nationally. At the global level, the United Nations 2030 Agenda includes Goal 2 (SDG2), Eradicate hunger, ensure food security, improve nutrition and promote sustainable agriculture, which includes reducing waste.

At EU level, the Farm to Fork strategy includes clear targets to reduce food waste. As part of the European Green Pact, the strategy's objectives must be met in the coming period, including reducing food waste. This will further contribute to the achievement of a circular economy and the sustainable development of the agri-food sector (European Commission, 2020, 2023).

In Romania, food waste is regulated by Law 217/2016 on reducing food waste by focusing on economic operators.

The reduction and prevention of food waste must be achieved at every stage of the food chain, starting with agriculture and the food industry, through the rational use of inputs in production processes, waste management, from collection to treatment, etc. Next, the distribution of products is done with cold chain to avoid losses, and stocks are based on scientific methods to avoid waste in this link of the food chain. For consumers, planning their purchases is a waste prevention measure. Studies (Falasconi et al., 2019) point out that food wastage at household level is linked to consumer behaviour caused by inattention or wrong

decisions, both in the store (at the buying stage) and in the household (at the preparation and consumption stage).

Conclusions

The economic dimension of food waste refers to the benefits resulting from the reduction of costs related to each link in the food chain and the efficient use of resources etc. Last but not least, reducing waste leads to reduced price volatility and stabilisation of agri-food markets, which has wider economic and social implications, ensuring food security for the population. Reducing food waste brings economic, social and environmental benefits, mainly through more efficient use of resources. However, significant, cross-sectoral challenges remain to be addressed, as demonstrated by previous research (Thyberg and Tonjes, 2016; Quested et al., 2013).

In conclusion, reducing food waste needs to be approached holistically, and the analysis of the phenomenon is carried out integrating all the implications mentioned, taking into account the potential impact of waste on the economy, the environment and society as a whole.

Acknowledgments

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